# CRASPEDELLINAE BAER, 1931 (PLATYHELMINTHES: TEMNOCEPHALIDA) ECTOSYMBIONTS FROM THE BRANCHIAL CHAMBER OF AUSTRALIAN CRAYFISH (CRUSTACEA: PARASTACIDAE) 

LESTER R.G. CANNON AND K1M B. SEWELL.


#### Abstract

Cannon, L.R.G. \& Sewell, K.B. 19951201 : Craspedellinac Baer, 1931 (Platyhelminthes; Temnocephalida) ectosymbionts from the branchial chamber of Australian crayfish (Crustacea: Parastacidae). Memoirs of the Queensland Museum 38(2): 397-418. ISSN 0079-8835.

Craspedellinae is recognised to include taxa of temnocephalids which live in the branchial chamber of Australian crayfish (Parastacidae) and are characterised by possession of one or more transverse papillate ridges across the dorsal body and cremulate (papillate) tentacles, i.e, 6 species of Craspedella Haswell, 1893, 5 of them new, all from eastern Australian Cherax sppp, and 3 new species of a new genus all from Western Australian Cherax spp., and a new genus and species from Euastacus bispinosus from Victoria. $\square$ Temnocephalida, Craspedellinae, Craspedella, crayfish, ectosymbionts, taxonomy:


Lester R.G. Cannon \& Kim B. Sewell, Queensland Museum, PO Box 3300, South Brisbane. Queensland 4101, Australia; 20 October 1995.

Craspedellaspenceri Haswell, 1893, described from the branchial chamber of Astacopsis bicarinatus Gray, 1845 [i.e. Cherax destructor Clark, 1936] from eastem Australia, is currently the only described species in the genus. Haswell (1893) characterised the species thus 'In the posterior half of the body, on the dorsal surface, are three transverse lamellae, 0.05 mm in breadth, divided into about 15-20 rounded lobes, each tipped with a few papillac....'. The only other temnocephalid known to have dorsal papillae is Notodactylus handschini Baer, 1953 which occurs on the carapace of Cherax spp. from Australia and New Guinea. In N. handschini the papillae are not raised on ridges or Jamellae and are retractile between the peculiar dorsal surface scales unique to this species (Jennings, Cannon \& Hick, 1992). One scutarielid, Bubalocercus sketi, from cave shrimps in Slovenia and Croatia is reported to have papillae 'strewn' all over the body (Matjasic, 1990).

The habitat of C. spenceri within the branchial chamber is sheltered and this small 'Jess than $2 \mathrm{~mm}{ }^{*}$, delicate and non-pigmented worm can easily go unnoticed; this is especially so when contrasted with the much larger '(about 0.5 cm )' Temnocephala dendyl Haswell, 1893 which also occurs in the branchial chamber of Cherax destructor, or the large, and often pigmented, temnocephalids obvious on the extemal exoskeleton of many of Australia's crayfish.

The crayfish branchial chamber often supports a rich fauna (Alderman \& Polglase, 1988; Cannon \& Jennings. 1987; Jennings, 1988) including temnocephalids: the Scutariellidac are found
there in shrimps from Europe (Matjasic, 1990) and Asia (Baer, 1953); in Australia the monotypic Actinodactylellidae is found in the branchial chamber of burrowing crayfish, and several members of the Temnocephalidae are now known from shrimps and crabs (Cannon, 1993). Although C. spenceri remains the only described species in the genus, researchers have examined small branchial chamber dwelling temnocephalids from Cherax spp. and have referred to them as either Craspedella sp. (see Rohde, 1987a,b; Jones \& Lester, 1992) of C. spenceri (see Cannon \& Jennings, 1987).
Examination of the branchial chamber of crayfish Cherax spp. and Euastacus spp. collected from around Australia during 1990-1992 as part of an Australian Biological Resource Study of the Temnocephalida revealed new taxa which are described here.

## MATERIALS AND METHODS

Live crayfish were captured in collapsible minnow traps baited with fatty mutton or canned cat food, and occasionally by dip netting, and were maintained for up to several hours in water from the habitat before they were dissected. To obtain living worms where captured crayfish were plentiful, the carapace was detached using strong forceps inserted anteriorly through the articular membrane and under the dorsal carapace, and the carapace and carcass placed into a shallow vessel containing water from the habitat. The inner surface of each branchiostegite (i.e., the branchiostegal membrane), the gills and the body wall were
searched with the aid of a dissecting microscope. Worms were collected on wooden points and transferred to a watch glass containing water. To obtain tiving worms where crayfish were rare, and needed intact for confirmation of host identification, several podobranchs were detached from the bases of the walking legs and placed in a watch glass containing water. Otherwise, the crayfish and any worms were killed and fixed by immersion in near boiling water (HW). All dismembered hosts, and when possible, additional intact host specimens were stored after HW fixation in $70 \%$ ethanol (Al) for subsequent taxonomic host identification and as a source of additional worm specimens. Where possible worms were drawn alive with the aid of a camera lucida, although for many species observations on living worms in the field was not possible.
For histology, living worms were flooded with fixative, usually cold $10 \%$ buffered formalin (Form), sometimes Bouin's fluid (Bouin) or acetic, formol, alcohol (AFA) ; some were fixed with Berland's fluid ( $10 \%$ formalin in glacial acetic acid). Some living worms removed from their host were fixed with hot water and transferred immediately to $10 \%$ phosphate buffered formalin (HW/Form). Where the crayfish host was collected by other than the collector of the worms the labelling convention - host collector/worm collector - is observed. Wholemounts were prepared by staining with either Mayer's or Harris' Haematoxylin $(\mathrm{Hx})$ and mounting in Canada balsam. Serial sections were prepared from worms embedded in $56^{\circ} \mathrm{C}$ Paraplast, cut at $6.7 \% \mathrm{~m}$ and stained with Mayer's haematoxylin and eosin (H\&E) or (rarely) using either Mallory's Trichrome (MT), Heidenhain's Azan (HA) or Heidenhain's Iron Haematoxylin (HIH) and mounted in Depex. All measurements were made with the aid of a camera lucida.
For scanning electron microscopy (SEM) worms were fixed by flooding with either (1) hot water (approx. $90^{\circ} \mathrm{C}$ ), then transferred to $10 \%$ phosphate buffered formalin (HW/Form), or (2) cold $3 \%$ glutaraldehyde ( $4^{\circ} \mathrm{C}$ ). Fixed worms were washed several times in distilled water to remove surface contamination, dehydrated in a graded alcohol series, critical point dried, mounted on stubs, coated with gold, and examined with a Hitachi S-530 SEM operating at 20 or 25 kV ,
For examination of the cirrus, worms were placed on a slide in a drop of de Faure's (deF) mounting medium (distilled water 50 ml ; chloral hydrate 50 g ; glycerol 20 ml and gum arabic 30 g ) on a microscope slide either alive, or in the case
of fixed specimens after rinsing in distilled water for 2-5 days to remove fixative, covered with a coverslip and examined using bright field and Nomarski microscopy. This technique clears the soft body tissue of the worms and provided much clearer images of the sclerotic male copulatory organ than those from stained wholemounts. Fixed worms cleared less effectively than live worms when placed in de Faure's medium. The shape of the vaginal cavity and its pattern of ridges and folds were also revealed by Faure's medium.
Taxonomic descriptions of worm species were prepared initially with the aid of the DELTA program (Dallwitz \& Paine, 1986) and based on measurements from the type series. Terminology follows that discussed by Cannon (1993). Matenial is deposited in the collections of the Queensland Museum (QM) and wholemouns are designated (WM), de Faure's cirrus preparations (CP) and serial sections (LS, TS or FS) -longitidinal, transwerse or facial sections: the number of slides in the series is given in brackets. Camera lucida drawings were scanned and used as templates for illustrations which were prepared using Adobe Illustrator, and photomictographs were scanned from 35 mm slide or negative film onto Kodak Photo CD, edited and assembled into plates using Adobe Photoshop.

## Measurements and Terminology

Considerable variation in the relative size, shape and position of internal structures was observed in living worms. This plasticity of shape and further distortion caused by the effects of fixative indicate that measurements are valuable only as a guide to the size and shape of the worms and their internal structures. Thus, the measurements we provide for soft structures and the cirrus are taken only from the large mature worms which comprise respectively the type series and de Faure's cirrus preparation series.
The terminology we use to describe the male reproductive structures essentially follows Cannon (1993). However, some reiteration and refinement of the terms are necessary. Following Cannon (1993), we term a cirrus the entire sclerotic male copulatory organ comprised of an introvert (flexible distal eversible region armed with spines) and sbaft (rigid, tapering, proximal, tubular region). The shaft tapers proximal to distal and is further classified to have the shape of either a funnel, a goblet or a cone. Funnel or goblet shaped shafts have a wide proximal region which tapers rapidly to form a narrow, tubular
distal region. Light microscopy reveals that the introvert is comprised of (1) an inner wall of thin sclerotic material which appears attached to, and effectively makes a continuation of, the shaft and from which the spines project inward and distally when not everted and (2) an outer layer of presumably sclerotic material optically distinct from the inner wall i.e., the swelling or enlargement described by Cannon (1993). The swelling varies in thickness over the length of the introvert being thinnest distally and continues proximally for a short distance past the base of the introvert to the distal region of the shaft. Our descriptions of the cirrus refer to the inverted state of the organ.
Measurements of cirrus length were made along the outside of the shaft wall but inside the introvert swelling. Measurements of total cirrus length were made along the longest side of the organ and include the introvest. Measurements of the width of the introvert base include the thickness of the shaft walls but exclude the introvert swelling. Measurements for the copulatory bulb exclude the cirrus. The arrangement and orientation of the prostate duct reservoirs within the copulatory bulb is characterised as approximately either parallel, diagonal, or at right angles in relation to the longitudinal axis of the copulatory bulb.

## SYSTEMATICS

CRASPEDELLINAE Baer, 1931

## Diagnosis

Temnocephalidae with oval or elliptical body slightly dorso-ventrally compressed, without latcral flanges and with five similar anterior tentacles. Tentacles with an annulate or crenulate appearance derived from prominent, conical, ciljated papillae arranged in near regular rows along and around a central axis. Rhabdite tracts to all tentacles, but most conspicuous in central three tentacles, with pore openings most concentrated in the ventro-distal region just posterior to the tip. Pigment confined to a single dorsal pair of eyes at the base of the tentacles. Posterior sucker pedunculate, strongly muscled, with a circular adhesive disc and marginal valve. Dorsal surface without imbricating scales, but with one or more transverse body ridges, bearing raised papillae: with dorsal body ridges arranged radially posterior to the most posterior transverse row also with raised papillae. Without locomotory cilia. Buccal cavity or pre-pharynx inconspicuous; pharynx directed antero-ventrally, tudimentary, undi-
vided; pharynx sphincters equal; oesophagus inconspicuous: gut without colour or septa. Gut as wide as long and usually seen extending posteriorly further on the right. Major nerve trunks inconspicuous; eyes present, spherical to ovoid, discrete but close; pigment granules irregular, black-brown and mainly small. Longitudinal and circular muscles of body wall usually of equal strength; body dorso-ventral muscles weak. Attachment muscles of pharynx weak. Muscles controlling the male organ and about seminal vesicle and copulatory bulb strong. Gonopore mid-ventral in posterior third of body; genital atrium commodious; without bursa copulatrix (but atrium may function as a bursa). Ovary spherical to ovoid; vesicula resorbiens usually spherical to ovoid/kidney-shaped. Vagina muscular, usually with bulbous sphincter distally; vaginal cavity without teeth but delineated by prominent longjtudinally oriented ridges and folds; seminal receptacle single; vitellaria scattered. Testes, two pairs anterior and posterior, spherical to ovoid, positioned lateral and posterion to gut respoctively, smooth to follicular. Ejaculatory sac where present contained in copulatory bulb. Prostate secretion fills copulatory bulb around ejaculatory duct. Dise glands scattered across dorsal body at about the posterior of posterior testes. Small, slender worms up to 2 mm in vivo. Inhabiting the branchial chamber of their hosts.

## REMARKS

Cannon (1986) recognised three families within the Temnocephalida - the monotypic Actinodactylellidae from Australia, the Scutariellidae from Europe and Asia, and the large and diverse Temnocephalidae from Madagascar, Asia, Australasia, and South and Central America.
Several genera of the Temnocephalidae are monotypic, Craspedella spenceri being unique in having papillae raised on dorsal ridges (Haswell, 1893). Baer (1931) originally proposed a separate family for this species, giving the following diagnosis:
"Temnocephalids of rather small size with five mobile tentacles at the anterior end. In the posterior region of the worm are three pairs of small tentacles situated on the edges of the animal and joined, two by two, on the dorsal surface, by a type of small dentate fringe, Behind the last fringe, at the posterior end, are four more small tentacles. The pharynx is rudimentary. The other anatomical characters are identical with those of the Temnocephalidae."


Baer (1931) obviously misinterpreted the description of Haswell (1893) and believed the edges of the papillate ridges (fringes) were small lateral tentacles. In fact the papillae are not necessarily larger than those elsewhere on the ridges and are not 'trois paires de petits tentacles situés sur les bords de l'animal'. Regardless, Bresslau \& Reisinger (1933) considered these characters insufficient to create a new family for this one species and Hyman (1951) and Baer (1961) accepted this. The discovery of new taxa, all sharing similar morphology, prompts the delineation of this group from the remainder of the Temnocephalidae.
Type genus: Craspedella Haswell, 1893
Other genera: Heptacraspedella gen. nov., Zysopellagen. nov.

## KEY TO CRASPEDELLINAE BAER, 1931

1. With more than one transverse papillate sidge on dorsal body and without pits, but with four papillate ridges which radiate towards the body margin behind the most posterior transverse ridge

With a single transverse papillate ridge on posterior dorsal body and a pair of posterior pits defined dorsally by a papillate ridge

Zygopella gen, nov. 3
2. With 3 transverse papillate dorsal ridges Craspedella 5
With 7 transverse papillate dorsal ridges
. . . Heptacraspedella peratus gen. et sp. nov.
3. Cirrus small, cone shaped and lacking large spines

Cirrus large, cone-shaped with large spines
Z deimala sp. nov.
4. Cirrus with wide introvert opening and junction between introvert and shaft ohlique Z pista sp. nov
Cirrus with narrow introvert opening; tentacles very rugose

Z stenola sp. nov.
5. Cirmus shaft distal region not reflexed; introvert not permanently everted, armed with spines .

Cirrus shaft distal region reflexed; introvert permanently everted, spines reduced to be flat, overlaid and "plate-like"
C. pedum sp. nov.
6. Cirrus not slender, thick-walled . . . . . . . . . 7

Cirmus slender, thin-walled
C. gracilis sp, nov.
7. Cimus shaft not conc-shaped and without thick proximas rinn Cirns shaft cone-shaped with thich proximal rim C. shomi sp. nov.
8. Cirrus shaft goblet-shaped; vagina with distinct "Iateral pocket" Cirrus shalt funnel-shaped with wide proximal opening: vagina without distinct "Jateral pocket"
C. spencen!
9. Cirmus shaft: ratio of length of tubular distal region to length of introvert about equal and never less than 1:1 . . . . . . . . . C. yabha sp. nov. Cirrus shaft: ratio of length of tubular distal region to length of introvers about 0.7:1 and always less than 1:1
C. simulator sp. 110v.

## Craspuedella Haswell, 1893

## Diagnosis

Craspedellinae with three dorsal papillake ridges in the posterior half of the body and, behind the last ridge, four short posterior papillate ridges radiating towards the posterior body margin. Excretory ampullac coiled, spherical to ovoid but not elongate. Vagina muscular, with distinct distal sphincter.

## Type Species

Craspedella spenceri Haswell, 1893

## Other Species

Craspedella gracilis sp, now.
Craspedella pedum sp. nov. Craspedella shorti sp. nov.
Craspedella simulator sp. nov.
Craspedella yabha sp. nov.

## Etymology

Haswell (1893) provided no derivation of the namc. Clearly it is from kraspedon (Greek; masculine; edge). The diminutive does not change the gender, so Craspedella is masculine meaning 'little edge', a reference to the dorsal papillate ridges.

FIG. 1. Scanning clectron micrographs of genera of Craspedellinae from type localities. Specimens fixed HW/Form. A, Craspedella spenceri Haswell, 1893. Note prominen lamellae. Scale $=500 \mu \mathrm{~m} . \mathrm{B}_{\mathrm{V}}$ Heptacraspedella peratus gen. et. sp. nov. Scale $=500 \mu \mathrm{~m}$. C. Zygopella pisra gen. \& sp. nov. Scale $=200 \mu \mathrm{~m}$ : Specimens fixed $3 \%$ glutaraldehyde. D, dorsal view of left lateral tentisele of Zygnpella, wenofa sp. nov, shozing rugose crenulations. Scale $=20 \mu \mathrm{~m}$. E. postcrior end of $2 y g$ opella pista showing paired posterior pits. Seale $=$ $50 \mu \mathrm{~m}$.

## Craspedella spenceri Haswell, 1893 <br> (Figs 1A. 2, 3, 4A, 10A,E)

## Material Examined

TYPE SPECIMENS (Lost, see remarks). NeOTYPE QMGL 18489 (WM), ex Cherax destractor Clark, 1936 from Condamine R., Warwick, QLD ( $28^{\circ} 11.39^{\circ} \mathrm{S} ; 151^{\circ} 57.50^{\prime} \mathrm{E}$ ) 24/Oc//1992 Sewell K.B. \& Sewell S.G. HW/Form/Hx-
Other Materlal: from QLD:-ex Cherax destracior same data as neotype HW/Form/H\&E QMGL1849018491 (L.S(1,1)), 4/Aug/1994 Sewell K.B. \& Joffe B. HW/deF QMGL18610 cimus inverted (CP[2], 2 adult specimens), QMGLI 8611 cirrus everted (CP[2], 2 adult specimens), 1/Sep/1994 Sewell K.B. HW/deF QMGL18612 cirtus inverted (CP[8], 8 adult specimens): from Western R., 1.5 km from Winton on Jundah Rd, QLD ( $22^{\circ} 24.2^{\prime} \mathrm{S} ; 143^{\circ} 02.2^{\prime} \mathrm{E}$ ) $22 / \mathrm{Nov} / 1990$ Cook S./Cannon L.R.G. Form/Hx QMGL18492 (WM): from Thompson R. at Longreach Waterhole, Longreach, QLD (23'24.7'S: $144^{\prime} 13.8^{\prime} \mathrm{E}$ ) 2/Oct/1990 Cannon L.R.G. \& Sewell K.B. HW/Form/Hx QMGL18493-18498, Bouin/H\&E QMGL 18499-18500 (LSS[1,1]) from Marlong Ck., Mt Moffat N.P. QLD ( $25^{\circ} 02^{\prime} \mathrm{S}$; 147 $7^{\circ} 54^{\circ} \mathrm{E}$ ) 26/Sep/1986 Momeith N.C. A1/Hx QMGL18501-18503 (WM): from Dawson R., Taroom, QLD ( $25^{\prime \prime} 39^{\circ} \mathrm{S} ; 149^{\circ} 48^{\prime} \mathrm{E}$ ) 3/Dec/1986 Cannon L.R.G. \& Jennings J. Form/Hx QMGL18504 (WM) - from Bungil Ck, Roma, QLD ( $26^{\prime} 30^{\prime}$ S: $148^{\circ} 48^{\prime}$ E) 2/Ded/1991 Cannon L.R.G. \& Jemnings J. Form/H\&E QMGLI8505 (WM), FAAA/H\&EQMGL18506(SS[5]); from Eukey, damal, QLD (28 $46.2^{\circ} \mathrm{S}$; $\left.151^{\circ} 59.2^{\prime} \mathrm{E}\right) 18 / \mathrm{Apr} / 1990$ Cook $\mathrm{S} . /$ Cannon L.R.G. Form/Hx QMGL18507-18508 (WM), 17/Apr/1990 Form/Hx QMGLI8509 (WM), QMGL 18510 (LS(1]): from Willows gemfield, in dam beside road, QLD ( $23^{\circ} 45^{\prime} \mathrm{S}$; $147^{\circ} 25^{\circ} \mathrm{E}$ ) $20 / \mathrm{Sep} / 199^{\circ}$ Cook S./Cannon L.R.G. Form/H\&E QMGL1851118513 (LS[1,1,1]):- cx Cherax depressus complex sensu Riek, 1951 from Wallaby Ck., on Henderson Rd. 0.2 km from Mi. Cotton Rd. junction, Sheldon, QLD ( $27^{\circ} 34,21^{\circ} \mathrm{S} ; 153^{\circ} 12.78^{\circ} \mathrm{E}$ ) $22 / \mathrm{Sep} / 1994$ Sewell K.B., Joffe B-, Solovei I.V. \& Solovei S.B. Form/Hx QMGL 18514-18516 (WM):
From NSW:- ex Cherax desirwctor, from Lake Madgwick, U.N.E. campus Armidale, NSW ( $30^{\circ} 31^{\prime \prime}$ S; $151^{\circ} 40^{\prime} \mathrm{E}$ ) 23/May/1991 Zoology DepL U.N.E. Bouin/Hx QMGLI8517-18523 (WM). Boum/H\&E QMGL18524 (flattened specimen LS [2]), QMGL18525-18527 (LS[1,1,2]): from Yarunga Ck. trib. 1.2 km NW Fitzroy Falls, Morton N.P, NSW ( $34^{\circ} 38.4^{\prime} \mathrm{S}$ : $150^{\prime 2} 28.4^{\prime} \mathrm{E}$ ) 19/Scp/l991 Cannon L.R.G. \& Sewell K.B. Form/Hx QMGL18528-18529 (WM), QMGL18530-18531 (LS[1,1), HW/Form/H\&E QMGLI8532 (LST]):
From SA:- (all collected by Beveridge I., fixed in Berland's fluid and stained in Mayer's Haemalum as wholemourts), ex Cherux desirucfor from Lake Alexandrina, via Clayton ( $35^{\circ} 25^{\prime} \mathrm{S} ; 139^{\circ} 10^{\prime} \mathrm{E}$ ) 20/Jan/1989 QMGL18533: from Cooper Ck.

26/Nov/1988 QMGLI8534: from the Narrows, via Clayton 2/Dec/1988 QMGL18535; from Bordertown ( $36^{\prime} 18^{\circ} \mathrm{S} ; 140^{\circ} 46^{\prime} \mathrm{E}$ ) $31 / \mathrm{Oct} / 1988$ QMGL $^{\prime} 8536$; from Lake Merreti ( $34^{\circ} 01^{\prime} \mathrm{S} ; 140^{\circ} 46^{\prime} \mathrm{E}$ ) 3/Dec/1988 QMGLGL 18537; from Avenue Ra. 18/Oct/1988 QMGL18538: from Mt. Benson ( $37^{\circ} 02^{\prime} \mathrm{S}$; 139.49'E) [8/Oct/1988 QMGL18539: from Bool Lagoon ( $37^{\circ} 09^{\circ} \mathrm{S}$; $140^{\circ} 43^{\prime} \mathrm{E}$ ) 4/Nov/1989 QMGL18540,

## DESCRIPTION

External. Body from posterior margin to tip of tentacles $1109 \mu \mathrm{~m}$, to eyes $761 \mu \mathrm{~m}$ long and $522 \mu \mathrm{~m}$ wide. Posterior disc $304 \mu \mathrm{~m}$ in diameter; peduncle $162 \mu \mathrm{~m}$ in diameter. Transyerse body ridges form promounced lamellae divided into lobes tipped with clusters of papillae. Epidermis about $2-3 \mu \mathrm{~m}$ high dorsally and ventrally,

General Anatomy. Pharynx $65 \mu \mathrm{~m}$ across. Excretory ampullae about $70 \mu \mathrm{~m}$ across. Eyes about $15 \mu \mathrm{~m}$ across.

Reproducrive System. Fentale. Ovary $90 \mu \mathrm{~m}$ across. Vesicula resorbiens $70 \mu \mathrm{~m}$ long, $35 \mu \mathrm{~m}$ wide, wall about $10 \mu \mathrm{~m}$ thick, embedded in gut wall. Seminal receptacle about $100 \mu \mathrm{~m}$ long and $27 \mu \mathrm{~m}$ wide. Vagina long.

Male. Anterior testes about $110 \mu \mathrm{~m}$ long, $70 \mu \mathrm{~m}$ wide. Posterior testes about $110 \mu \mathrm{~m}$ logg, $70 \mu \mathrm{~m}$ wide, Seminal vesicle $80 \mu \mathrm{~m}$ long, $50 \mu \mathrm{~m}$ wide. Copulatory bulb $69 \mu \mathrm{~m}$ long, $62 \mu \mathrm{~m}$ wide, with ejaculatory sac. Prostate duct reservoirs parallel. Cirrus (based on 10 adult fully inverted specimens fixed HW/deF ex QMGL18611 and GL18612) $176-196 \mu \mathrm{~m}(\bar{x}=185 \mu \mathrm{~m})$ long in total. Shaft funnel-shaped, curved, thick walled, with distal region less than length of introvert; proximal opening $46-76 \mu \mathrm{~m}(\bar{x}=60 \mu \mathrm{~m})$ wide, with narrow rim. Introvert strongly curved, $13-17 \mu \mathrm{~m}$ ( $\bar{x}=15 \mu \mathrm{~m}$ ) wide at base, longer side $71.83 \mu \mathrm{~m}$ $(\bar{x}=78 \mu \mathrm{~m})$ long, shorter side $38-49 \mu \mathrm{~m}(\overline{\mathrm{x}}=43 \mu \mathrm{~m})$ long (i.e. introvert about 5 times longer than width of introvert base), with clearly asymmetrical swelling i,e, much wider on longer side, distal opening $20-27 \mu \mathrm{ml}(\overline{\mathrm{x}}=24 \mu \mathrm{~m})$ wide.

Hasts. Cherat destructor Clark, 1936; Cherax depressus group sensu Riek, 1951 : Parastacidac.

Localify. Murray-Darling river system and east coast streams.

## Remarks

Type specimens were not located despite a careful search of the collections al the Austrahan Museum. Sydney and at the McLeay Museum at the University of Sydney. Haswell worked in both institutions, but evidently failed to lodge type specimens of the worms he described, A search for data which might indicate the lecalities


FGG 2. Craspedella spenceri Haswell, 1893, Nentype, Scale $=250 \mu \mathrm{~m}$.
from which he obtained crayfish hosts and thus indicate type localities failed to providc useful information. In Haswell's time the crayfish Astacopsis bicarinatus Gray, 1845 was the name for what is now known to be several species of Cherax found in eastem Australia. Cherax destructor, however, is by far the most common and wide spread of specics and is found throughout the Murray-Darling system. The specimens we obtained from this host conform closely with the majority of Haswell's description and thus confirm the validity of the species. However,

Haswell (1893) apparently confused the cirrus of C. spenceri, in our view the most important taxonomic character, with that of another closely related species described below (see Haswell, 1893 Plate XIII, Fig. 21). Moreover, the widespread distribution of C. spenceri may result in some variation in body size and form between localities and hosts (see below section on Craspedella sp. from Cherax albidus Clark, 1936). Since nomenclatural instability could potentially develop and thus circumstances are somewhat exceptional, a neotype has been erected

## Craspedella gracilis sp. nov. (Fig. 4B)

Material Examined
Holotype: QMGL18429 (WM). ex Cherax depressus from Marlborouth. creek beside caravan park. QLD ( $22^{\circ} 49.2^{\prime} \mathrm{S} ; 149^{\circ} 53.2^{\prime} \mathrm{E}$ ) 21/Sep/1990 Cannon L.R.G. \& Sewell K.B. HW/Form/Hx.
Paratypes: Same data as holotype. QMGL18430-18431 (WM), QNGL 18432 (LS[1]).
Other Materiat: Same data as hololype, HW/Form/Hx QMGL18433. 184.35 (WM), QMGL18436 (LS[J]). HW/AFA/H\&E QMGL18437 (WM). HW/Form/dcF QMGL 18613 cirrus inverted (CP|2). 4 adult, 1 young specimens).

## DEsCRIPTION

External: Body from postenor margin to tip of tentacles $510-$ $605 \mu \mathrm{~m}(\bar{x}=550 \mu \mathrm{~m})$, to eyes $323-$ $391 \mu \mathrm{~m}$ ( $\bar{x}=354 \mu \mathrm{~m}$ ) long and $170-198 \mu \mathrm{~m}(\mathrm{x}=187 \mu \mathrm{~m})$ wide; Posterior dise $102-115 \mu \mathrm{~m}$ ( $\overline{\mathrm{x}}=106 \mu \mathrm{~m}$ ) in diameter; peduncle $58-68 \mu \mathrm{~m}$ ( $\bar{x}=62 \mu \mathrm{~m}$ ) in diameter. Transverse body ridges do not form lamellae. Epidermis about $2-3 \mu \mathrm{~m}$ high dorsally and ventrally.

General Anatomy. Pharynx $27-34 \mu \mathrm{~m}$ ( $\bar{x}=30 \mu \mathrm{~m})$ long, $30-34 \mu \mathrm{~m}(\bar{x}=33 \mu \mathrm{~m})$ wide, Gastrodermis about $25 \mu \mathrm{~m}$ high. Excretory ampullac $24-34 \mu \mathrm{~m}(\bar{x}=31 \mu \mathrm{~m})$ long, $10-17 \mu \mathrm{~m}(\bar{x}=15 \mu \mathrm{~m})$ wide. Eyes about $8 \mu \mathrm{~m}$ across.
Reproducrive System. Female. Ovary $30-34 \mu \mathrm{~m}$ ( $\bar{x}=31 \mu \mathrm{~m}$ ) across. Vesicula resorbiens $45-68 \mu \mathrm{~m}$
( $\mathrm{x}=58 \mu \mathrm{~m}$ ) across, wall $3-5 \mu \mathrm{~m}$ thick. Seminal receptacle about $36 \mu \mathrm{~m}$ long, $9 \mu \mathrm{~m}$ widc.
Male. Anterior testes about 34-4Jرm ( $\overline{\mathrm{x}}=39 \mu \mathrm{~m}$ ) long, $25-30 \mu \mathrm{~m}(\overline{\mathrm{x}}=28 \mu \mathrm{~m})$ wide. Posterior testes about $52-68 \mu \mathrm{~m}$ ( $\bar{x}=60 \mu \mathrm{~m}$ ) long and $29-41 \mu \mathrm{~m}(\bar{x}=35 \mu \mathrm{~m})$ wide. Seminal vesicle 54 $60 \mu \mathrm{~m}(\bar{x}=56 \mu \mathrm{~m})$ long, $25-36 \mu \mathrm{~m}(\bar{x}=31 \mu \mathrm{~m})$ wide. Copulatory bulb, $27-34 \mu \mathrm{~m}$ ( $\bar{x}=31 \mu \mathrm{~m}$ ) long, $30-$ $37 \mu \mathrm{~m}(\overline{\mathrm{x}}=33 \mu \mathrm{~m})$ wide, with ejaculatory sac. Prostate duct reservoirs parallel. Cirrus (based on 4 fully inverted adult specimens ex QMGLi8613) 157-168 $\mu \mathrm{m}(\bar{x}=163 \mu \mathrm{~m})$ long in total. Shaft narrow, goblet-shaped, curved, thinwalled, with distal region about same length as introvert; proximal opening $22-29 \mu \mathrm{~m}(\bar{x}=24 \mu \mathrm{~m})$ wide, with narrow rim. Introvert slightly curved, $6-7 \mu \mathrm{~m}(\overline{\mathrm{x}}=7 \mu \mathrm{~m})$ wide at base, longer side $61-$ $61 \mu \mathrm{~m}(\bar{x}=61 \mu \mathrm{~m})$ long, shorter side $44-52 \mu \mathrm{~m}$ $(\bar{x}=48 \mu \mathrm{~m}$ ) long (i.e. introvert about 9 times longer than width of introvert base), with narrow asymmetrical swelling i.e. wider on Ionger side, distal opening angled, about $6-8 \mu \mathrm{~m}(\bar{x}=7 \mu \mathrm{~m})$ wide.

Hosis. Cherax depressus complex sensu Rick, 1951: Parastacidae.
Locality. Mariborough, central eastern QLD.

## ETYMOLOGY

Latin, gracilis, slender, referring to the slenderness of the cirrus.

## Remarks

The slender, delicate cirrus clearly distirguishes this species. In wholemounted specimens the cirrus shaft is often severely contorted, and the introvert considerably narrowed, presumably as a result of the effects of fixation.

Craspedella pedum sp, nov.
(Figs 4C, 10C)
Craspedefla sp. Sewell \& Cannon, 1995; 151; Sewell \& Whittington, 1995: 1121; Watson, Rohde \& Sewell, 1995: 131.

## MATERIAL EXAMINED

Holotype; QMGL 18461 (WM), ex Cherax quadricarinatus (von Martens, 1868) from University of Queensland aquaculture ponds, Pinjarra Hills, QLD (27"32.38'S; 152'55.18'E) 15/May/1992 Sewell K.B. HW/Form/Hx,
Paratypes:Same data as holotype, QMGL18462 (WM), 19/Apr/1991 HW/Form/Hx QMGL18463 (WM), 30/Mar/1992 Bouin/H\&E QMGL18464 (LS[1]), 22/Dec/1992 Bouin/MT QMGLI8465 (LS[1]).

Other Materiali ex Cherax quadricarinatus (Von Martens, 1868 ) from University of Queensland aquacutture ponds, Pinjarra Hills, QLD ( $27^{\circ} 32.38^{\circ}$ S; 152'55.18'E) 1991-1993 HW/Form/Hx QMGL18466-18472 (WM), Bouin/Hx QMGL18473 (LS[1]), Form/HA QMGL18474 (LS[1]), Form/HIH QMGL18475 (LS[1]), HW/deF QMGL18626 cirrus everted (CP[5] 10 adults, 15 juveniles or damaged): (Mitchell R. stock) From Walkamin, D.P.I. Research Station aquaculture ponds, QLD ( $17^{\circ} 08^{\circ} \mathrm{S} ; 745^{\circ} 25^{\prime} \mathrm{E}$ ) 25/Sep/1990 Cannon L.R.G. \& Sewell K.B. AFA/Hx QMGL18476 (WM), Bоuin/Hx QMGL 18477 (WM); from East Leichardt R., 50 km SW Mt. Isa, QLD (20'56'S: $139^{\circ} 45^{\prime}$ E 3/May/1993) Monteith G.B. AI/Hx QMGL18478-18488(WM).

## DESCRIPTION

External. Body from posterior margin to tip of tentacles $739-896 \mu \mathrm{~m}(\mathrm{x}=800 \mu \mathrm{~m})$, to eyes 497 $616 \mu \mathrm{~m}(\bar{x}=544 \mu \mathrm{~m})$ long and 223-34 $6 \mu \mathrm{~m}$ ( $\bar{x}=278 \mu \mathrm{~m}$ ) wide. Posterior dise $157-186 \mu \mathrm{~m}$ ( $\bar{x}=171 \mu \mathrm{~m}$ ) in diameter; peduncle $69-107 \mu \mathrm{~m}$ ( $\bar{x}=83 \mu \mathrm{~m}$ ) in diameter. Transverse body ridges do not form lamellac. Epidermis about $2-3 \mu \mathrm{~m}$ high dorsally and ventrally.

General Anatomy. Pharynx $37-48 \mu \mathrm{~m}$ ( $\bar{x}=43 \mu \mathrm{~m}$ ) long, $27-39 \mu \mathrm{~m}(\bar{x}=33 \mu \mathrm{~m})$ wide, Gastrodermis about $30 \mu \mathrm{~m}$ high. Excretory ampollae about $44-62 \mu \mathrm{~m}$ long ( $\bar{x}=51 \mu \mathrm{~m}$ ) long, $27-45 \mu \mathrm{~m}$ $(\bar{x}=34 \mu \mathrm{~m})$ wide. Eyes about $14 \mu \mathrm{~m}$ across.

Reproductive System. Female. Ovary 31-55 $\mu \mathrm{m}$ ( $\bar{x}=45 \mu \mathrm{~m}$ ) long, $27-47 \mu \mathrm{~m}$ ( $\bar{x}=37 \mu \mathrm{~m}$ wide), Vesicula resorbiens $91-130 \mu \mathrm{~m}(\bar{x}=106 \mu \mathrm{~m})$ long, 56$89 \mu \mathrm{~m}(\overline{\mathrm{x}}=72 \mu \mathrm{~m})$ wide, wall about $10 \mu \mathrm{~m}$ thick. Seminal seceptacle about $34 \mu \mathrm{~m}$ long, 11 mm wide.

Male. Anterior testes $46-67 \mu \mathrm{~m}(\overline{\mathrm{x}}=58 \mu \mathrm{~m})$ leng, $31-53 \mu \mathrm{~m}(\bar{x}=45 \mu \mathrm{~m})$ wide. Posterior testes 72 $94 \mu \mathrm{~m}(\bar{x}=81 \mu \mathrm{~m})$ long, $34-50 \mu \mathrm{~m}(\bar{x}=44 \mu \mathrm{~m})$ wide. Seminal vesicle strongly muscled $105-144 \mu \mathrm{~m}$ $(\bar{x}=118 \mu \mathrm{~m})$ long, $41-58 \mu \mathrm{~m}(\bar{x}=48 \mu \mathrm{~m})$ wide. Copulatory bulb $73-86 \mu \mathrm{~m}(\overline{\mathrm{x}}=79 \mu \mathrm{~m})$ long, $73-98 \mu \mathrm{~m}$ ( $\bar{x}=83 \mu \mathrm{~m}$ ) wide, with ejaculatory sac. Prostate duct reservoirs parallel. Cirrus (based on 10 adult specimens ex QMGL18266) 236-283 1 m ( $\bar{x}=264 \mu \mathrm{~m}$ ) long in total. Shaft funnel-shaped, strongly curved (reflexed) distally; proximal opening $69-112 \mu \mathrm{~m}(\bar{x}=96 \mu \mathrm{~m})$ wide, with narrow rim; outside wall of reflex widened at point of introvert 'eversion' muscle insertion. Introvert permanently everted, forming rigid flange 48$59 \mu \mathrm{~m}(\bar{x}=54 \mu \mathrm{~m})$ long; without obvious swelling. Spines reduced to be flat, overlaid, welded together' and 'plate-like'.

Hosts, Cherax quadricarinalus (Von Martens, 1868): Parastacidae.

Locality, Queensland.


FIG. 3. Reproductive structures of Craspedella spenceri. Scalc $=50 \mu \mathrm{~m}$,
B./Sewell K.B. 14/Sep/1994

Form/Hx QMGL18456-18460 (WM), HW/deF QMGL 18614 cimus inverted (CP[3], 3 adults), QMGL18615 cirns everted (CP[5],5 adult specimens).

## DESCRIPTION

External. Body from posterior margin to tip of tentacles 414$761 \mu \mathrm{~m}(\overline{\mathrm{x}}=608 \mu \mathrm{~m})$, to eyes 352 $515 \mu \mathrm{~m} \quad(\hat{x}=427 \mu \mathrm{~m})$ long and $311-435 \mu \mathrm{~m} \quad(\bar{x}=327 \mu \mathrm{~m})$ wide. Posterior disc 137-140 m $(\bar{x}=138 \mu \mathrm{~m})$ in diameter; peduncle $65-90 \mu \mathrm{~m}(\overline{\mathrm{x}}=78 \mu \mathrm{~m})$ in diameter. Transverse body ridges do not form Iamellae. Epidermis about $2 \mu \mathrm{~m}$ high dorsally and ventrally,

General Anatomy. Pharynx 32$72 \mu \mathrm{~m}$ ( $\bar{x}=56 \mu \mathrm{~m}$ ) long, 43-80 $\mu \mathrm{m}$ ( $\mathrm{x}=58 \mu \mathrm{~m}$ ) wide. Gastrodermis about $27 \mu \mathrm{~m}$ high. Excretory amtpullae $45-60 \mu \mathrm{~m}(\bar{x}=53 \mu \mathrm{~m})$ long,

## Etymology

Latin, pedum, shepherd's crook, referring to the $u$-shaped reflex of the distal portion of the cirrus shaft. This is a noun in apposition.

## REMARKS

Morphology of the male cirrus is unique and serves to distinguish this species. The muscle insertion point of the introvert 'eversion ${ }^{*}$ muscle on the reflex becomes thicker with age. The aberrant form of the apparently permanently everted introvert required that the standard measurement protocol had to be modified.

Craspedella shorti sp. nov,
(Figs 4D, 10D)

## Material Examined

HoLotype: QMGL18450 (WM), ex Cherax depressus from roadside gully on Mumford Rd., Narangbah, QLD ( $27^{\circ} 12.34^{\circ} \mathrm{S}$; $152^{\circ} 57.42^{\prime} \mathrm{E}$ ) $18 / \mathrm{Mar} / 1992$ Short J/Sewell K.B, HW/Form/Hx.
Paratypes: Same data as holotype, QMGL18451, (WM): ex Cherax depressus from Wallaby Ck,, on Henderson Rd, $0,2 \mathrm{~km}$ from Mt. Cotton Rd, junction, Sheldon Brisbane, QLD ( $27^{\circ} 34.21^{\prime} \mathrm{S}$; $153^{\circ} 12.78^{\prime} \mathrm{E}$ ) Cannon L.R.G \& Joffe B./Sewell K.B. 14/Sep/1994 Form/Hx QMGLI8452 (WM), Bouin/H\&E QMGL18453 (LS[1/1]).
Other Material: Same dala as holotype, HW/Form/Hx QMGL18454-18455 (WM); ex Cherax depressus from Wallaby Ck., on Henderson Rd. 0.2 km from Mt. Cotton Rd. junction, Sheldon Brishane, QLD ( $27^{\circ} 34.21^{\prime} \mathrm{S} ; 153^{\circ} 12.78^{\prime}$ E) Cannon L.R.G \& Joffe
$21-30 \mu \mathrm{~m}(\bar{x}=26 \mu \mathrm{~m})$ wide. Eyes about $13 \mu \mathrm{~m}$ across. Posterior glands present and discharging in two postero-lateral regions (see remarks).

Reproductive System. Female. Ovary $40-43 \mu \mathrm{~m}$ ( $\bar{x}=41 \mu \mathrm{~m})$ across, Vesicula resorbiens $93-126 \mu \mathrm{~m}$ ( $\bar{x}=111 \mu \mathrm{~m}$ ) long, $93-72 \mu \mathrm{~m}(\bar{x}=78 \mathrm{~m} \mu \mathrm{~m})$ wide, wall $8-11 \mu \mathrm{~m}$ thick. Seminal receptacle about $50 \mu \mathrm{~m}$ long, $16 \mu \mathrm{~m}$ wide.

Male. Anterior testes about $54-68 \mu \mathrm{~m}$ $(\bar{x}=60 \mu \mathrm{~m})$ long, $36-47 \mu \mathrm{~m}(\bar{x}=43 \mu \mathrm{~m})$ wide. Posterior testes about $74-91 \mu \mathrm{~m}(\bar{x}=81 \mu \mathrm{~m})$ long, 40$50 \mathrm{~m}(\bar{x}=45 \mu \mathrm{~m})$ wide. Seminal vesicle $97-112 \mu \mathrm{~m}$ $(\bar{x}=103 \mu \mathrm{~m})$ long, $40-49 \mu \mathrm{~m}(\bar{x}=43 \mu \mathrm{~m})$ wide. Copulatory bulb $83-101 \mu \mathrm{~m}(\bar{x}=93 \mu \mathrm{~m})$ long, $62-75 \mu \mathrm{~m}$ ( $\bar{x}=68 \mu \mathrm{~m}$ ) wide, without ejaculatory sac. Prostate duct reservoirs at right angles (except in most proximal region of the bulb). Cirrus (based on 7 adult specimens ( 3 inverted, 4 everted) ex QMGL18614 and QMGLI8615) 153-169 1 m ( $\mathrm{x}=161 \mu \mathrm{~m}$ ) long in total. Shaft cone-shaped, curved, thick walled; proximal opening $29-38 \mathrm{~m}$ ( $\bar{x}=32 \mu \mathrm{~m}$ ) wide, with very thick rim. Introvert not curved, $10-15 \mu \mathrm{~m}(11 \mu \mathrm{~m})$ wide at base, both sides almost same length, longer side 45$47 \mu \mathrm{~m}(\bar{x}=46 \mu \mathrm{~m})$ long, shorter side 42 $47 \mu \mathrm{~m}(\bar{x}=44 \mu \mathrm{~m})$ long (i.e. introvert about 4 times longer than width of introvert base), with near symmetrical swelling, distal opening 13 $17 \mu \mathrm{~m}(\mathrm{x}=15 \mu \mathrm{~m})$ wide.

Hosts. Cherax depressus complex sensu Riek, 1951 : Parastacidae.
Lecality. south castern QLD.

## Etymology

For John Short, Crustacea Section QM who collected the host from which the first specimen was recognised.

## Remarks

The prostate duct reservoirs in the copulatory bulb being at right angles to the long axis of the bulb form a distinctly baccate pattern which serves to distinguish this species, as does the thick proximal rim of the cirrus shaft. Postero-lateral glands similar to those observed for this species have been described previously (see Cannon, 1993). The nature of similar glands from Temnocephala minor are the subject of a separate study by Cannon \& Watson (in press).

## Craspedella simulator sp. nov. (Figs 4E, 10F)

Craspedella spenceri: Cannon \& Jemnings, 1987

## MATERIAL Examined

Holotype: QMGL1854] (WM), ex Cherax dispar From Woodgate Lagoons, beside Childers io Woodgate Rd., QLD (25"07.4'S; 152"30.6'E) 6/Apr/1991 Sewell K.B. HW/Form/Hx.

Paratypes: Same data as holotype, QMGL 18542 18543 (WM); QMGL 18544 (LS[1]).
Other material: From QLD;- ex Cherax dispar same data as holotype, QMGL18545-18553 (WMD). QMGL18554 (LS[1]), 18/Sep/1990 Cannon L.R.G. \& Sewell K.B. HW/Form/Hx QMGLI8555 (WM), HW/Form/deF QMGL18816 cimus inverted (CP[2]. 5 adult, 2 young specimens): also ex Cherax dispar from Gap Ck., in Gap Ck. Reserve picnic ground, BrookGield,QLD (27"28.68' ${ }^{\circ}$; $152^{\prime} 55.71^{\prime} \mathrm{E}$ ) 3/Sep/1984 Hall N. \& FrancisS. Bouin/Hx QMGL.18556-18557 (WM), Bouin/H\&E QMGL18558 (TS [2]), 12/Dec/1984 Cannon L.R.G. FAA/Hx QMGLI8559-18563 (WM), PAA/H\&E QMGL18564-18565 (LS[1.1]: from Wallaby Ck., on Henderson Rd. 0.2 km from Mi. Cotlon Rd. junction, Sheldon Brisbane, QLD ( $27^{\circ} 34.21$ 'S; $153^{\circ} 12.78^{\prime}$ E) Sewell K.B., Joffe B, Solovei I.V. \& Solovei S.B. 19/Scp/1994 Form/Hx QMGL1856618573 (WM), 14/Sep/1994 Cannon L.R.G.\& Joffie B/ $/$ Sewell K.B. deF QMGLI 8617 cirrus everted (CP[1)], 1 adult specimen): ex Cherax depressus from Wallaby CE,, on Henderson Rd. 0.2 km from Mt, Cotion Rd. junction, Sheldon, Brisbase, QLD ( $27^{\circ} 34.21^{\prime}$ S: $153^{\prime} 12.78^{\prime}$ E) Sewell K.B., Joffe B., Solovei I.V. \& Solovei S.B. 19/Sep/1994 Form/Hx QMGL1857418576 (WM): ex Chehax destrucror from Thompson R. at Longreach Waterhole, Longreach, QLD ( $23^{\prime} 24.7$ S ; $144^{\circ} 13.8^{\prime}$ E) 2/Oct/1990 CannonL.R.G. \& Sewell K.B. FAA/Hx QMGLI8577 (WM) HW/Form/Hx QMGLI8578 (WM): from Longreach. QLD (23'27*S; 144*15'E) 13/Dec/1990 Cook S/Cannion L.R.G. Form/H\&E QMGL18579-18580 (WM):
from Condamine R., Warwick, QLD ( $28^{\prime} 11.39^{\prime} \mathrm{B}$; $151^{\circ} 57.50^{\circ}$ E) $24 / \mathrm{Oct} / 1992$ Sewell K.B. \& Sewell S.G. HW/Form/Hx QMGLI8581-18589 (WM).
From NSW:- cx Cherax destructor from a tributary of Yarunga Ck, 1.2 km NW Fitzroy Falls, Morton N.P., NSW ( $34^{*} 38.4^{\prime} \mathrm{S}$; $150^{\circ} 28.4^{\prime} \mathrm{E}$ ) 19/Sep/1991 Cañón L.R.G. \& Sewell K.B. HW/Form/Hx QMGLI859018591 (WM), QMGL18592 (LS[1]): ex Cherax cuspidntus from Wauchope, roadside swamp beside 'Tjimbertown'. NSW ( $31^{\circ} 28.4^{\circ} \mathrm{S}$; $152^{\prime \prime} 42.8^{\prime} \mathrm{E}$ ) 15/Feb/1992 Sewell K.B. \& Sewell S.G.HW/Form/Hx QMGL18593-18594, Form/Hx QMGL18595-18598 (WM) QMGL 18599-18600 (LS[1,1]).
From SA- (all collected by Beveridge L, fixed in Berland's fluid and stained in Mayer's Haemalum as wholemounts): ex Cherar destructor from Tod R. ( $34^{\prime} 30^{\circ} \mathrm{S}$; $135^{\circ} 51^{\prime} \mathrm{E}$ ) 9/Mar/1989 QMGLI8601: from Springbett, Gawler ( $34^{\circ} 36^{\circ}$ S; $138^{\circ} 45^{\circ} \mathrm{E}$ ) 23/Jan/1989 QMGL18602: from Murray R., Murray Bridge ( $35^{\circ} 07^{*} \mathrm{~S}$; $139^{*} 16^{\prime} \mathrm{E}$ ) $10 / \mathrm{Feb} / 1989$ QMGL18603: from Onkaparinga R. ( $35^{\circ} 00^{\circ} \mathrm{S} ; 138^{\circ} 49^{\circ} \mathrm{E}$ ) $22 / \mathrm{Nov} / 1989$ QMGLis604: from Light R., Kapunda ( $34^{\prime 2} 21^{\prime}$ S; [38'55'E) 1/Mar/1989, QMGL18605; from Inman R. ( $35^{\circ} 30^{\circ}$ S: $138^{*} 31^{\prime} \mathrm{E}$ ) 19/Noy./1988 QMGLI8606: from Strawberry Hill Springs ( $34^{\circ} 31^{\circ} \mathrm{S}$; $135^{\circ} 43^{\prime} \mathrm{B}$ ) 9/Mar'1989 QMGL18607: from Broughton R., Spalding ( $33^{\prime} 30^{\prime} \mathrm{S}$; $138^{\circ} 37^{\circ}$ E) 29/Mar/1989 QMGLI8608: from Gerard Yabbic Farm, Berri ( $34^{\circ} 17^{\circ} \mathrm{S}$; $140^{\circ} 36^{\circ} \mathrm{E}$ ) 19/Jan/1989 QMGL18609.

## DESCRIPTION

External. Body from posterior margin to tip of tentacles $476-506 \mu \mathrm{~m}(x=486 \mu \mathrm{~m})$; to eyes 313 $347 \mu \mathrm{~m}$ ( $\mathrm{x}=331 \mu \mathrm{~m}$ ) long and $205-210 \mu \mathrm{~m}$ ( $\bar{x}=207 \mu \mathrm{~m}$ ) wide; Posterior disc $95-110 \mu \mathrm{~m}$ ( $\mathrm{x}=103 \mu \mathrm{~m}$ ) in diameter; peduncle $51-58 \mu \mathrm{~m}$ $(\bar{x}=55 \mu \mathrm{~m})$ in diameter. Transverse body ridges do not form lamellae. Epidermis about $2 \mu$ mhigh dorsally and $3 \mu \mathrm{~m}$ high ventrally.
General Anatomy. Pharynx 30-34 $\mu \mathrm{m}$ ( $\bar{x}=31 \mu \mathrm{~m})$ long, $34-36 \mu \mathrm{~m}(\bar{x}=35 \mu \mathrm{~m})$ wide, Gastrodermis about $20 \mu \mathrm{~m}$ high. Excretory ampallae about $40 \mu \mathrm{~m}$ long. $20 \mu \mathrm{~m}$ wide. Eyes about $9 \mu \mathrm{~m}$ across.
Reproductive System. Female. Ovary $32-36 \mu \mathrm{~m}$ ( $\bar{x}=34 \mu \mathrm{~m}$ ) across. Vesicula resorbiens $54-60 \mu \mathrm{~m}$ ( $\bar{x}=56 \mu \mathrm{~m}$ ) across, wall 5 -10um thick. Seminal receptacle about $58 \mu \mathrm{~m}$ long, $19 \mu \mathrm{~m}$ wide. Vagina with pronounced lateral pocket.

Mate. Anterior testes about $30-44 \mu \mathrm{~m}$ $(\bar{x}=38 \mu \mathrm{~m})$ long, $18-40 \mu \mathrm{~m}(\bar{x}=31 \mu \mathrm{~m})$ wide. Posterior testes about $38-78 \mu \mathrm{~m}(\bar{x}=56 \mu \mathrm{~m})$ long and $27-35 \mu \mathrm{~m}(\overline{\mathrm{x}}=31 \mu \mathrm{~m})$ wide. Seminal vesicle 54 $63 \mu \mathrm{~m}(\bar{x}=58 \mu \mathrm{~m})$ long, $23-26 \mu \mathrm{~m}(\mathrm{x}=25 \mu \mathrm{~m})$ wide. Copulatory bulb, $34-40 \mu \mathrm{~m}$ ( $(\bar{x}=38 \mu \mathrm{~m})$ long, 44 $49 \mu \mathrm{~m}$ ( $\bar{x}=47 \mu \mathrm{~m}$ wide, with cjaculatory sac. Prostate duct reservoirs parallel. Cimus (based on 5 adult specimens ex QMGL18816) 176-186 $\mu \mathrm{m}$


FIG 4. Nomarski interference photomicrographs of cirri of adult worms ex type host and locality unless stated: A, Craspedella spenceri (i) inverted; (ii) partially everted. B, Craspedella gracilis sp. nov., inverted; C, Craspedella pedum sp. nov.; D, Craspedella shorti sp. nov. (i) invented, (ii) partially everted; Craspedella simulator sp. nov. (i) inverted, (ii) inverted ex Cherax dispar from Wallaby Ck., Sheldon, QLD, (iii) partially everted ex Cherax dispar from Wallaby Ck, Sheldon, QLD. Scale $=100 \mu \mathrm{~m}$.
$(\bar{x}=180 \mu \mathrm{~m})$ long in total. Shaft, goblet-shaped, slightly curved, thick-walled, with distal region shorter than length of introvert; proximal opening $38-43 \mu \mathrm{~m}(\bar{x}=41 \mu \mathrm{~m})$ wide, with narrow rim. In-
trovert curved, $11-13 \mu \mathrm{~m}(\overline{\mathrm{x}}=12 \mu \mathrm{~m})$ wide at base, longer side $70-77 \mu \mathrm{~m}(\overline{\mathrm{x}}=72 \mu \mathrm{~m}$ ) long, shorter side $64-70 \mu \mathrm{~m}(\bar{x}=66 \mu \mathrm{~m})$ long (i.e. introvert about 6 times longer than width of introvert base), with


FIG. 5. Nomarski interference photomicrographs of cirri of adult worms ex type host and locality unless stated:
A, Craspedella yabba sp. nov., (i) inverted (ii) partially everted; B, Craspedella sp., inverted; C, Heptacraspedella peratus gen. \& sp. nov., part everted; D, Zygopella pista gen. \& sp. nov., partially everted; E, Zygopella deimata sp, nov. partially everted; F, Zygopella stenota sp. nov., invertcd. Scale $=100 \mu \mathrm{~m}$.
clearly asymmetrical swelling i.e. much wider on longer side, distal opening $11-17 \mu \mathrm{~m}(\bar{x}=14 \mu \mathrm{~m})$ wide.
Hosts. Cherax cuspidatus Riek, 1969; Cherax depressus complex sensu Riek, 1951; Cherax destructor Clark, 1936; Cherax dispar Riek, 1951: Parastacidae.

Locality. eastern Australia.

## Etymology

Latin, simulator, an imitator which refers to the close resemblance of this species to that of $C$. spenceri. This is a noun in apposition.

## Remarks

Although superficially resembling C. spenceri with which it frequently co-inhabits the branchial chamber this worm is generally smaller, has a more elongate body shape, much less pronounced transverse body ridges, ie. they do not form lamellae, a goblet-shaped cirrus with a narrower introvert, and a smaller vagina which has a pronounced lateral pocket (Fig. 10F).

## Craspedella yabba sp. nov.

(Fig. 5A)

## MAterial Examined

Holotype: QMGL 18438 (WM), ex Cherax depressus from Conondale Ra,, State Fores 792, QLD $\left(26^{\circ} 47^{\prime} \mathrm{S}\right.$; $\left.152^{\circ} 32^{\circ} \mathrm{E}\right) 16 / \mathrm{Sep} / 1994$ Smith G,/Sewell K.B. Bouin/Hx.

Paratypes: Same data as holotype, Form/Hx QMGL18439 (WM), Bouin/H\&E QMGL18440 (FS [11), GL 18441 (LS[1]).
Other Materlal: Same data as holotype, Form/Hx QMGL18442 (WM), Bouin/H\&E QMGL 18443 (LS[1]), HW/deF QMGL18618 cirrus inverted (CP[1], 1 adult specimen), QMGL 18619 cirrus everted (CP[2], 2 adult specimens): ex Cherax dispar from Booloumba Ck. at first road crossing E of Little Yabba Ck. Rest Area ( $26^{\circ} 37.0^{\circ} \mathrm{S}$; $152^{\circ} 39.1^{\prime} \mathrm{E}$ ) $23 / \mathrm{Mar} / 1990$ Cannon L.R.G. \& Sewell K.B. HW/AFA/Hx QMGL18444 (WM), Bouin/H\&E QMGL18446-18447 (LS[1,1,); from Conondale Ra., QLD ( $26^{\circ} 44^{\circ} \mathrm{S}$; $152^{\circ} 43^{\prime}$ 'E) 17/Nov./1983 Cannon L.R.G. Form Hx QMGL18445 (WM), FAA/H\&E QMGL18448 (LS[1]), QMGL18449 (LS[2]).

## DESCRIPTION

External. Body from posterior margin to tip of tentacles $336-380 \mu \mathrm{~m}(\bar{x}=358 \mu \mathrm{~m})$, to eycs 25 $285 \mu \mathrm{~m}(\mathrm{x}=270 \mu \mathrm{~m})$ long and $200-22 \mathrm{~s} \mu \mathrm{~m}$ ( $\bar{x}=211 \mu \mathrm{~m}$ ) wide. Posterior dise $95 \mu \mathrm{~m}$ in diameter, peduncle about $58 \mu \mathrm{~m}$ in diameter. Transverse body ridges do not form lamellae. Epidermis about $2-5 \mu \mathrm{~m}$ high dorsally and ventrally.

General Anatomy. Pharynx $25-27 \mu \mathrm{~m}$ ( $\bar{x}=26 \mu \mathrm{~m})$ long, $25-27 \mu \mathrm{~m}(\bar{x}=26 \mu \mathrm{~m})$ wide, Gastrodermis about $37-44 \mu \mathrm{~m}$ high. Excretory ampullae about $28 \mu \mathrm{~m}$ long, $20 \mu \mathrm{~m}$ wide. Eyes about $12 \mu \mathrm{~m}$ actoss.
Reproductive System. Female. Ovary $40-41 \mu \mathrm{~m}$ $(\bar{x}=41 \mu \mathrm{~m})$ long, $18-21 \mu \mathrm{~m}(\bar{x}=20 \mu \mathrm{~m})$ wide. Vesicula resorbiens $36-54 \mu \mathrm{~m}(\bar{x}=45 \mu \mathrm{~m})$ across, wall $6-9 \mu \mathrm{~m}$ thick. Seminal receptacle about $9-11 \mu \mathrm{~m}$ across. Vagina with distinct lateral pocket.

Male. Anterior testes about $27-43 \mu \mathrm{~m}$ $(\bar{x}=35 \mu \mathrm{~m})$ long, $31-37 \mu \mathrm{~m}(\bar{x}=34 \mu \mathrm{~m})$ wide. Posterior testes ahout $58-66 \mu \mathrm{~m}(\overline{\mathrm{x}}=62 \mu \mathrm{~m})$ long, 27 $28 \mu \mathrm{~m}(\overline{\mathrm{x}}=28 \mu \mathrm{~m})$ wide. Seminal vesicle $43-45 \mu \mathrm{~m}$
( $\bar{x}=44 \mu \mathrm{~m}$ ) long, $23-25 \mu \mathrm{~m}(\bar{x}=24 \mu \mathrm{~m}$ ) wide. Copulatory bulb, $31-31 \mu \mathrm{~m}(\overline{\mathrm{x}}=31 \mu \mathrm{~m})$ long, $39-40 \mu \mathrm{~m}$ $(\bar{x}=40 \mu \mathrm{~m})$ wide, with ejaculatory sac. Prostate duct reservoirs parallel. Cirrus (based on 3 adult specimens (1 inverted, 2 everted) ex QMGL18618) $188-196 \mu \mathrm{~m}(\bar{x}=191 \mu \mathrm{~m})$ long in total. Shaft, goblet-shaped, curved, me-dium/thick-walled, with distal region longer than length of introvert; proximal opening $43-45 \mu \mathrm{~m}$ ( $\bar{x}=44 \mu \mathrm{~m}$ ) wide, with narrow rim. Introvert slightly curved, $12-13 \mu \mathrm{~m}(13 \mu \mathrm{~m})$ wide at base, longer side $65-67 \mu \mathrm{~m}(x=66 \mu \mathrm{~m})$ long, shorter side $57-57 \mu \mathrm{~m}(\overline{\mathrm{x}}=57 \mu \mathrm{~m})$ long (i.e. introvert about 5 times longer than width of introvert base), with asymmetrical swelling i.e. wider on longer side, distal opening about $15 \mu \mathrm{~m}$ wide.
Hosts. Cherax dispar Riek, 1951; Cherax depressus complex sensu Rick, 1951 : Parastacidae.
Locality. Conondale Ra., QLD.

## Etymology

A noun in apposition, yabba means forest in the local Waka language of the Aboriginal people and refers to the type locality, the Conondale Ranges.

## REMARKS

C. yabba is very close to $C$. simulator in general body form and the morphology of the cirrus. However, the cirrus of C. yabba has a shorter introvert and the ratio of the length of the tubular distal region of the shaft to the length of the introvert is never less than $1: 1$ compared to that for $C$. sinudator which is clearly less than $1: 1$. Moreover the introvert swelling on the longer and shorter sides of the introvert are more equal in thickness than those of C. simulator.

Craspedella sp. 1
(Fig. 5B)

## Material Examined

Ex Cherax albidus Clark, 1936 from Dwyers Ck, 2 km SSW Mirrantawa, VIC ( $37^{\circ} 24^{\circ} \mathrm{S} ;^{\prime} 142^{\circ} 23^{\prime} \mathrm{E}$ ) 5/Oed/1991 Cannon L.R.G. \& Sewell K.B. HW/Form/Hx, QMGL $18420-18425$ (WM). Form/Hx QMGL 18426 (WM), HW/Form/deF QMGL 18620 cifrus inverted (CP[1]).

## Remarks

The distinctiveness of the crayfish species Cherax albidus, the host of these worms, from Cherax destructor is uncertain (see Morrissy \& Cassells, 1992). The worms appear close to C. simulator in general anatomy including the form


FIG. 6. Heplacraspedella peramus gen. et sp. nov. Holotype. Scale $=250 \mu \mathrm{~m}$.
of the transverse and posterior nidges, however, they show some slight differences in the shape of the cirrus which in the shaft at least (Fig. 5B) resembles that of $C$. spenceri. The worms may prove a further distinct species. The small number of specimens collected and the large geographical range of C. destructor/albidus makes us hesitant to erect a new species of Craspedella at this time.

## Heptacraspedella gen nov.

## DiAgnosis

Craspedellinae with seven dorsal transverse papillate ridges, and behind the last ridge, four short posterior papillate ridges consisting of raised
points radiating towards the posterior body margin. Excretory ampullae strongly coiled and elongate. Muscles about seminal vesicle and copulatory bulb relatively very strong. Distal vaginal sphincter not pronounced.

## Type Species

Heptacraspedella peratus sp. nov.

## ETYMOLOGY

Greek, hepta, seven, a reference to the number of ridges or edges.

## REMARKS

The number and form of the dorsal ridges are quite different from those of Craspedella spenceri and other new members of that genus. The host, Euastacus, is also of a different genus; Craspedella spp. have only been lound on members of Cherax. Parenchymal gland cell bodies (?mucus glands) were observed positioned laterally between the anterior and posterior testes (Fig. 6).

Heptacraspedella peratus sp. nov. (Figs 1B,5C,6,7,10B)

## Material Examined

Holotype: QMGL18403 (WM), ex Euastacus bispinosus from Jimmys Ck., Grampians, at pienic ground 6.5 km WNW Mafeking, VIC ( $37^{\circ} 23^{\prime} \mathrm{S}$; $142^{\circ} 34^{\prime}$ E) 5/Ocd 1991 Cannon L.R.G. \& Scwell K.B. HW/Form/Hx.
Paratypes: Same data as holotype, QMGL1840418405 (WM), Form/H\&E QMGL18406-18407 (LS[1,1].
Other Material: Same data as holotype. QMGL18408-18419 (WM), HW/Form/deF QMGL18621 cimus everted (CP[4], 9 adult ( 1 bent), 1 young specimen(s)).

## DESCRIPTION

External. Body from posterior margin to tip of tentacles $848-870 \mu \mathrm{~m}(\bar{x}=862 \mu \mathrm{~m})$, to eyes 565 $580 \mu \mathrm{~m} \quad(\bar{x}=575 \mu \mathrm{~m})$ long and $290-304 \mu \mathrm{~m}$ ( $\bar{x}=300 \mu \mathrm{~m}$ ) wide. Posterjor disc $137-152 \mu \mathrm{~m}$ ( $\bar{x}=142 \mu \mathrm{~m}$ ) in diameter; peduncle $72-72 \mu \mathrm{~m}$ ( $\bar{x}=72 \mu \mathrm{~m}$ ) in diameter. Epidermis about $4 \mu \mathrm{~m}$ high dorsally, about $5 \mu \mathrm{~m}$ high ventrally.
General Anatomy. Pharynx 33-50 m ( $\bar{x}=40 \mu \mathrm{~m}$ ) long, $33-50 \mu \mathrm{~m}(\bar{x}=40 \mu \mathrm{~m})$ wide. GasIrodermis about $35 \mu \mathrm{~m}$ high. Excretory ampullae elongate $65-65 \mu \mathrm{~m}(\bar{x}=65 \mu \mathrm{~m})$ long and $25-25 \mu \mathrm{~m}$ ( $\bar{x}=25 \mu \mathrm{~m}$ ) wide. Eyes about $15 \mu \mathrm{~m}$ across.
Reproductive System. Female. Ovary about $55 \mu \mathrm{~m}$ across. Vesicula resorbiens $116-123 \mu \mathrm{~m}$

Zygopella gen. nov.


FIG. 7. Reproductive structures of Heptacraspedella perarus gen. et sp. nov. Scale $=50 \mu \mathrm{~m}$.
( $\bar{x}=118 \mu \mathrm{~m}$ ) across, wall about $15 \mu \mathrm{~m}$ thick, embedded in gut wall, not open to gut. Seminal receptacle at least $12 \mu \mathrm{~m}$ long.
Male. Anterior testes about $70-80 \mu \mathrm{~m}$ ( $\overline{\mathrm{x}}=76 \mu \mathrm{~m}$ ) across. Posterior testes about 108$156 \mu \mathrm{~m}(\bar{x}=131 \mu \mathrm{~m})$ long and $40-50 \mu \mathrm{~m}(\bar{x}=44 \mu \mathrm{~m})$ wide. Seminal vesicle strongly muscled 58 $101 \mu \mathrm{~m}(\bar{x}=75 \mu \mathrm{~m})$ long, $43-45 \mu \mathrm{~m} \quad(\bar{x}=44 \mu \mathrm{~m})$ wide. Copulatory bulb $101-130 \mu \mathrm{~m}(\bar{x}=118 \mu \mathrm{~m})$ long, $80-87 \mu \mathrm{~m}(x=82 \mu \mathrm{~m})$ wide, without ejaculatory sac. Prostate duct reservoirs oblique (except in most proximal region of bulb). Cirrus (based on 8 adult specimens (all everted) ex QMGL18621) $76-104 \mu \mathrm{~m}$ ( $\bar{x}=93 \mu \mathrm{~m}$ ) long in total. Shaft cone-shaped, not curved, thick walled; proximal opening $51-89 \mu \mathrm{~m}$ ( $\overline{\mathrm{x}}=75 \mu \mathrm{~m}$ ) wide, with slightly thickened rim. Introvert 32 $35 \mu \mathrm{~m}(\mathrm{x}=33 \mu \mathrm{~m})$ wide at base, sides about equal length $38-42 \mu \mathrm{~m}(\bar{x}=40 \mu \mathrm{~m})$ long (i.e. introvert slightly longer than width of introvert base), distal opening unable to be determined accurately due to lack of fully inverted specimens (about $10 \mu \mathrm{~m}$ wide), with wide, near symmetrical swelling.
Hosts. Euastacus bispinosus Clark, 1941: Parastacidae.
Locality. Jimmys Ck., Grampians, VIC.

## Etymology

Latin, peratus, western/edge, refering to having a host species at the western most edge of the sunge of its genus (Euastacus).

## Diagnosis

Craspedellinae with a single transverse papillate ridge lacking lobes across the posterior body: and with a pair of pits behind it each defined dorsally by a horseshoe-shaped papillate ridge. Vagina musculature with distinct distal sphincter.

Type Species
Zygopella pista sp. nov.

## Other Species

Zygopella deimata sp. nov.
Zygopella stenota sp. nov.

## ETYMOLOGY

Greck, zygon, yoke and Greck (feminine), pella, cup, i.e. symmerrical cups.

## Remarks

The possession of only a single papillate ridge and, instead of 4 posterior ridges, a pair of pits each defined by a horseshoe-shaped papillate ridge, clearly distinguishes Zygopella from Craspedella and Heptacraspedella.

> Zygopella pista sp. nov.
> (Figs 1C, E,5D,8:9)

## Material Examined

Holotype: QMGLI 8326 (WM), ex Cherax inn. uimanus from Margaret $\mathrm{R}_{\text {., }}$ at water catchment weir. WA ( $33^{\prime \prime} 57.0^{\prime}$ S; $115^{\circ} 05^{\prime} 2 \mathrm{E}$ ) 23/Jan/1992 Cannon L.R.G. \& Sewell K.B. HW/Form/Hx.

Paratypes: Same data as holotype. QMGL18327 (WM), QMGL 18328 (WM), Bouin/H\&E QMGL18329-30 (LS[1,1], Bouin/H\&E QMGL18331 (FS[3]).
Other Materlal: Same data as holotype, QMGL18332-63 (WM), Bouin /H\&E QMGL18364 (LS[1]), QMGL18365 (LS[2]), QMGL18366 (LS[1]), QMG18367 (LS[1]). QMGL18368 (LS[1]). HW/Form/deF QMGL18622 cirrus everted (CPI5], 5 aduli specimens): also ex Cherax tenuimanus from "Margaret R. Marron Farm", 10 km SE Margaret R., WA Australia ( $34^{\circ} 00.8^{\circ} \mathrm{S}$; $115^{\circ} 09.5^{\circ} \mathrm{E}$ ) 23/Jan/1992 Cannon L.R.G. \& Sewell K.B. HW/Form/Hx QMGL18369-18373 (WM), Bouin/H\&E QMGL18374 (FS[2]), QMGL18375 (LS[2]). Bouin/H\&E QMGL18376-18380 (LS[1]).


FlG. 8. Zygopella pista gen. \& sp, nov. Holotype. Scale $=250 \mu \mathrm{~m}$,

## DESCRIPTION

External. Body from posterior margin to tip of tentacles $667-884 \mu \mathrm{~m}(x=748 \mu \mathrm{~m})$, to eyes $457-$ $616 \mu \mathrm{~m}$ ( $\bar{x}=513 \mu \mathrm{~m}$ ) long, and $348-417 \mu \mathrm{~m}$ ( $\bar{x}=378 \mu \mathrm{~m}$ ) wide. Posterior dise $137-150 \mu \mathrm{~m}$ $(\bar{x}=144 \mu \mathrm{~m})$ in diameter; peduncle $72-87 \mu \mathrm{~m}$ ( $\bar{x}=78 \mu \mathrm{~m}$ ) in diameter. Epidermis about $2 \mu \mathrm{~m}$ high dorsally and ventrally.
General Anaromy. Pharynx 38-50 $\mu \mathrm{m}$ ( $\bar{x}=44 \mu \mathrm{~m}$ ) across, Gastrodermis about $45 \mu \mathrm{~m}$
high. Excretory ampullae $40-45 \mu \mathrm{~m}$ $(\bar{x}=42 \mu \mathrm{~m})$ across. Eyes about $15 \mu \mathrm{~m}$ across with short, narrow pigment tails that descend ventrally.

Reproductive System. Female. Ovary about $47 \mu \mathrm{~m}$ across. Vesicula resorbiens $100-120 \mu \mathrm{~m}$ ( $\bar{x}=107 \mu \mathrm{~m}$ ) across; wall about 3 $5 \mu \mathrm{~m}$ thick. embedded in gut wall, not open to gut. Seminal receptacle about $10 \mu \mathrm{~m}$ long.
Male. Anterior testes about $73-$ $87 \mu \mathrm{~m}(\overline{\mathrm{x}}=80 \mu \mathrm{~m})$ across. Posterior testes about $73-108 \mu \mathrm{~m}$ ( $\bar{x}=85 \mu \mathrm{~m}$ ) across. Seminal vesicle $80-110 \mu \mathrm{~m}$ ( $\bar{x}=99 \mu \mathrm{~m}$ ) long. $\quad 36-50 \mu \mathrm{~m}$ ( $\bar{x}=43 \mu \mathrm{~m}$ ) wide, strongly muscled. Copulatory bulb $100-130 \mu \mathrm{~m}$ ( $\bar{x}=119 \mu \mathrm{~m}$ ) long, $\quad 36-50 \mu \mathrm{~m}$ ( $\bar{x}=44 \mu \mathrm{~m}$ ) wide; with ejaculatory sac. Prostate duct reservoirs oblique. Cirmus (based on 5 adult specimens (all everted) ex QMGL18622) $\quad 54-66 \mu \mathrm{~m}$ $(\bar{x}=61 \mu \mathrm{~m})$ long in total. Shaft, cone-shaped, curved, thin walled; proximal opening $25-29 \mu \mathrm{~m}$ ( $\bar{x}=27 \mu \mathrm{~m}$ ) wide with narrow rim. Introvert $10-10 \mu \mathrm{~m}$ ( $10 \mu \mathrm{~m}$ ) wide at base with junction between introvert and shaft oblique, longer side $20-22 \mu \mathrm{~m}(\bar{x}=21 \mu \mathrm{~m})$ long, shorter side $16-17 \mu \mathrm{~m}(\vec{x}=17 \mu \mathrm{~m})$ long (i.c. introvert about two times longer than width of base), with thin. asymmetrical swelling, i.e. wider on longer side of introvert, distal opening width not able to be determined accurately due to lack of fully inverted specimens (about $7 \mu \mathrm{~m}$ wide).
Hosts. Cherax tenuimanus (Smith, 1912): Parastacidae.
Locality. Margaret R., WA (wild and in culture).

## ETYMOLOGY

Greek, pistos, faithful and refers to the retention of this species with its host even when placed into culture, a situation which sees the external natural temnocephalid replaced with a translocated species (Cannon \& Sewell, 1994).


FIG. 9. Reproductive structures of Zygopella pista gen. ci sp. nov. Scale $=50 \mu \mathrm{~m}$.

Zygopella deimata sp. nov. (Fig. 5E)

## Material Examined

Holotype: QMGL18381 (WM), ex Cherax tenuiphanus from Inlet R., on South Western Highway to Walpole, WA ( $34^{\circ} 55.2^{\prime} \mathrm{S}$; $116^{\circ} 34.2^{\prime} \mathrm{E}$ ) $25 / \mathrm{Jan} / 1992$ Cannon L.R.G. \& Sewell K.B. HW/Form/Hx.
Paratype: Same data as holotype, QMGL18428 (L.S|2]).

Other Material: Same data as holotype, HW/Form/AcF QMGLI 8623 cirrus cverted (2 adult specimens).

## DEsCRIPTION

Exiernal. Body from posterior margin to tip of tentacles $792 \mu \mathrm{~m}$, to eyes $540 \mu \mathrm{~m}$ long and $306 \mu \mathrm{~m}$ wide. Posterior dise $122 \mu \mathrm{~m}$ in diameter; peduncle $65 \mu \mathrm{~m}$ in diameter. Epidermis about $2-3 \mu \mathrm{~m}$ dorsally and ventrally.

General Anatomy. Pharynx $35 \mu \mathrm{~m}$ long, $50 \mu \mathrm{~m}$ wide: Gastrodermis about $60 \mu \mathrm{~m}$ high. Excretory ampullae thjek walled about $47 \mu \mathrm{~m}$ across. Eyes abrout $12 \mu \mathrm{~m}$ across.

Reproductive System. Female. Ovary $50 \mu \mathrm{~m}$ long, $21 \mu \mathrm{~m}$ wide. Vesicula resorbiens $144 \mu \mathrm{~m}$ across, wall $21 \mu \mathrm{~m}$ thick. Vagina with pronounced distal sphincter and very prominent proximal longitudinal folds.

Male. Anterior testes about $83 \mu \mathrm{~m}$ across. Posterior testes about $90 \mu \mathrm{~m}$ across. Seminal vesicle $90 \mu \mathrm{~m}$ long, $63 \mu \mathrm{~m}$ wide, strongly muscular. Copulatory bulb $100 \mu \mathrm{~m}$ long, $63 \mu \mathrm{~m}$ wide, without ejaculatory sac. Prostate duct reservoirs oblique. Cirrus (based on 2 everted specimens cx QMGL18623) 119-12 $\mu \mu \mathrm{m}(\bar{x}=120 \mu \mathrm{~m})$ long in total. Shaft conc-shaped, not curved, thick-
walled; proximal opening 82 $86 \mu \mathrm{~m}(\bar{x}=84 \mu \mathrm{~m})$ wide with thackened rim. Introvert 16-17 1 m ( $\bar{x}=17 \mu \mathrm{~m}$ ) wide at base, both sides about $34 \mu \mathrm{~m}$ long (i.e. introvert about two times longer than widl of base), distal opening unable to be determined accurately due 10 lack of fully inverted specimens, with near symmetrical swellıng. Proximal spines very large, with at least three large dagger-shaped spines, about $30 \mu \mathrm{~m}$ long posjtioned centrally and apparently attached to introvert base.

Hosis. C. senuimanus (Smith. 1912): Parastacidac.

Locality: Inlet R., W'A.

ETYMOLOGY
Greek, decimatos, a fearful thing, referring to the robust nature of the cirrus and its spincs.

## Remarks

Only a few specimens were collected. How. ever, the species is distinct, as the cimus is large and quite unlike the modest cone found in 2 . pisia.

> Zygopella stenota sp. nov.
> (Figs 1D, 5F)

## Material Examined

Holotype: QMGL18382 (WM), ex Cherax c.f quinquicarinatus from Inlet R., on South Wextern Highway to Waipole, WA (34*55.2 $\mathrm{S} ; 116^{\circ} 34.2^{\circ} \mathrm{E}$ ) 25/Jan/1992 Cannon L.R.G. \& Sewell K.B. Bouin/Hx. Paratypes: Same data as holotype, QMGLI8383. 18384 (WM). Bouin/H\&E QMGLI8385-18386 (LS[1,1]).
Other Material: Same data as holotype. QMGL18387-18389 (WM), Bouin/dcF QMGLI8624 (cirrus inverted (CP[2], 2 adult specimens). QMGL 18625 cimus evented (CP[6], 6 adult specimens): ex Cherax temuinarus from Inlet R., on South Western Highway to Walpole, WA ( $34^{\circ} 55.2^{\circ} \mathrm{S}$; $116^{\circ} 34.2^{\prime}$ E) 25/Jan/1992 Camon L.R.G. \& Sewell K.B. HW/Form/Hx QMGL18390-18392 (WM), QMGL18427 HW/Form/H\&E (LS[1]): ex Cheraxc.f. bicarinahus from Deep R. tributiry, circa 4 km N MI. Pingerup, WA ( $34^{\circ} 50.4^{\circ} \mathrm{S} ; 116^{\circ} 32.4^{\circ} \mathrm{E}$ ) 25/Jar/1992 Cannon L.R.G. \& Sewell K.B. HW/Form/Hx QMGL18393-18402 (WM).

## DESCRIPTION

External. Body from posterior margin to tip of tentacles $476-570 \mu \mathrm{~m}$ ( $\bar{x}=515 \mu \mathrm{~m}$ ), to eyes 335.

$407 \mu \mathrm{~m} \quad(\bar{x}=356 \mu \mathrm{~m})$ long, and $251-272 \mu \mathrm{~m}$ $(\bar{x}=261 \mu \mathrm{~m})$ wide. Posterior disc $103-122 \mu \mathrm{~m}$ ( $\bar{x}=111 \mu \mathrm{~m}$ ) in diameter; peduncle $44-63 \mu \mathrm{~m}$ $(\bar{x}=53 \mu \mathrm{~m})$ in diameter. Tentacles with very rugose crenulations.
General Anatomy, Pharynx $18-25 \mu \mathrm{~m}$ ( $\bar{x}=22 \mu \mathrm{~m})$ long, $25-37 \mu \mathrm{~m}(\overline{\mathrm{x}}=31 \mu \mathrm{~m})$ wide, Gastrodermis about $35-44 \mu$ m high. Excretory ampullae $28-40 \mu \mathrm{~m}$ across. Eyes about $9 \mu \mathrm{~m}$ across.

Reproductive System. Female. Ovary about $25 \mu \mathrm{~m}$ across. Vesicula resorbiens kidney-shaped $63-96 \mu \mathrm{~m}(\overline{\mathrm{x}}=82 \mu \mathrm{~m})$ long, $43-59(\bar{x}=51 \mu \mathrm{~m})$ wide, walls about $8 \mu \mathrm{~m}$ thick. Seminal receptacle about $10 \mu \mathrm{~m}$ long.
Male. Anterior testes about $70-100 \mu \mathrm{~m}$ $(\bar{x}=86 \mu \mathrm{~m})$ long, $37-49 \mu \mathrm{~m}(\bar{x}=42 \mu \mathrm{~m})$ wide. Posterior testes about $70-94 \mu \mathrm{~m}(\overline{\mathrm{x}}=82 \mu \mathrm{~m})$ long, 44 $57 \mu \mathrm{~m}(\bar{x}=50 \mu \mathrm{~m})$ wide. Seminal vesicle $59-71 \mu \mathrm{~m}$ ( $\bar{x}=65 \mu \mathrm{~m}$ ) long, $36-45 \mu \mathrm{~m}$ ( $\bar{x}=41 \mu \mathrm{~m}$ wide), strongly muscled, it and copulatory bulb show a distinct semi-spiral arrangement of muscles. Copulatory bulb $57-65 \mu \mathrm{~m}(\overline{\mathrm{x}}=61 \mu \mathrm{~m})$ long, $33-$ $39 \mu \mathrm{~m}(\bar{x}=36 \mu \mathrm{~m})$ wide, with accessory sac. Prostate duct reservoirs parallel. Cirrus (based on 8 adult specimens except measurements of the width of the distal introvert based on two inverted specimens ex QMGL18624 and 18625) $38-47 \mu \mathrm{~m}$ $(\bar{x}=43 \mu \mathrm{~m})$ long in total. Shaft, cone-shaped, curved, thin-walled; proximal opening $15-19 \mu \mathrm{~m}$ ( $\bar{x}=16 \mu \mathrm{~m}$ ) wide with narrow rim. Introvert $3-4 \mu \mathrm{~m}$ $(\bar{x}=3 \mu \mathrm{~m})$ wide at base, both sides $6-8 \mu \mathrm{~m}$ $(\bar{x}=7 \mu \mathrm{~m})$ long (i.e. introvert about 2,5 times longer than width of base), distal opening 3-4 m $(\bar{x}=4 \mu \mathrm{~m})$ with narrow, near symmetrical swelling.
Hosts. Cherax c.f. bicarinatus (Gray, 1845); C. c.f. quinquicarinatus (Gray, 1845); C. tenuimanus (Smith, 1912): Parastacidae.
Locality. Deep R. and Inlet R., WA.

## Etymology

Greek, stenotes, inarrow referring to the narrowness of the cirnus introvert.

## Remarks

Evidently quite close to the type species C. pista, but with a characteristically narow cirrus. The seminal vesicle and copulatory bulb show a distinct semi-spiral arrangement of muscles. The tentacles of all the specimens we observed had extremely rugose crenulations independent of fixation, compared to the other species (Fig. 1D).

## DISCUSSION

For over 100 years Craspedella spenceri has been the only temnocephalan species recognised with papillate posterior dorsal ridges. Other species have possibly been confused with it (c.g., Cannon \& Jennings, 1987), The small size and delicate nature of these worms, and their cryptic habitat in the branchial chamber, has evidently ensured the richness of the fauna was overlooked.
The distinctive facies of this group of genera with their well developed papillate ridges and erenulate tentacles presumably relate to their habitat, the branchial chamber. The relationship of form, function and habitat are the subject of continuing detailed studies by one of us (KBS) on $C$. pedum from the 'redclaw' Cherax quadricarinatus:

We have recognised the Craspedellinae and include in it 3 genera comprising a lotal of 11 species of temnocephalans, all from the branchial chamber of crayfish and characterised by possession of crenulate tentacles and one or more transverse dorsal papillate ridges, The morphological differences between this group and the remainder of the Temnocephalidae are insufficient in our opinion, to justify the re-erection of the family Craspedellidae created by Baer (1931). In this we concur with Bresslau \& Reisinger (1933), but the similar facies of so many taxa indicates a subfamily rank is appropriate.

As with many small worms, fixation to provide consistent form for comparison is difficult. Cold fixation usually ensures considerable distortion. The hot water treatment was effective in producing uniform fixation of extended worms suitable

[^0]for wholemounts, although it could be considered only 'adequate' for preparation of specimens for sectioning. Similarly the quality of the SEM fixation for this study was only adequate and this prompted the study of Sewell \& Cannon (1995) to determine an optimum fixation regime for the SEM of Craspedella pedum.

In the wild, $C$. spenceri and $C$. simulator $\alpha c-$ curred together in the branchial chamber of 2 species of Cherax. Co-occurrence was also observed with Z stenota and Z. diemata on C. fenuimunus. It is of ecological interest that different yet closely related species of Craspedellinae co-inhabit the branchial chamber microhabitat of a single crayfish host. In particular, questions are raised as to how such a niche is partitioned.

The strong association of the Craspedellinae with Cherax spp. crayfish raises issues of host phylogeny, taxonomy and biogeography e.g, the occurrence of Zygopella spp, on Cherax of Western Australia and not Craspedella spp. which are confined to Cherox of eastern Australia. These questions can hopefolly be addressed after analyses of the distribution of many potential new species of temnocephalan species collected from Alistralian Cherax spp. in the course of fieldwork associated with the present study. Evidence for a high diversity of temnocephalan species associated with Euastacus was presented by Cannon \& Sewell (1994).

It is perhaps not surprising that distinctive Heptacraspedella occurs on the crayfish Euastacus. The two crayfish genera Cherax and Euastacus are distinct and show considerable differences in habitat and life style. Cherax are commonly found in slower, lowland or coastal streams, often (but not always) with open canopy above: Euastacus prefers fast, and often high country, streams with a closed forest canopy. In examination of many species of Euastacus from Cape York to the Grampians this was the only occasion on which gill temnocephalans (with the exception of Didymorchis spp. which were not included in this study) were detected. Most often Euastacus specimens were collected by hand from the edges of streams and though many were mature and were host to external temnocephalans the crayfish were usually small. If large specimens of Euaztacus can be obtained from traps other species of gill dwelling temnocephalans may be found.
Our species descriptions rely more heavily on descriptions of the cirrus than previous recent publications ón Australian Ternnocephalida (e.g. Hickman, 1967; Cannon, 1991, 1993). The cirrus
introvert is a reliable character to separate species because it is the cimus structure which is first formed in juveniles and its dimensions, unlike those of the cirrus shaft, remain constant as the worms age (unpublished observations). The use de Faure's medium allows more accurate detail of the morphology of the cirrus than has been available in the past. We did not base the separation of species on the dimensions and arrangement of the introvert spines, as these characters could not always reliably be determined, particularly from specimens fixed prior to placement in de Faure's medium. Furthermore, the introvert swelling was often difficult to observe in specimens which were placed live into de Faure's medium as it appeared to clear more than for specimens fixed previously. Moreover, when the cirrus was everted, the swelling was obscured. Therefore, we excluded the introvert swelling from our measurements of the cirrus.
The original description of Craspedella spenceri Haswell. 1893 was based largely on the lamellate, papillate frills of the species. We were able to clearly recognise this species with large lamellations and prominent lobes tipped with papillae, which we have called C. spencert'. These features were observed even on small juvenile worms. However, the cirrus figured by Haswell (1893) does not conform to that which we observed for this species. The goblet shape of the shaft and the narrow width of the introvert suggest that this cirrus belongs instead to $C$. simulator which we observed to co-inhabit the branchial chamber of the crayfish Cherax destructor over a wide geographical area. Furthermore, Haswell (1893) apparently figured the cirrus erroncously as he drew the teeth of the inverted introvert as pointing proximally not distally as we observed for all the species we studied. Similarly, we did not observe the ejaculatory sac to be discrete as figured by Haswell (1893). In all species of Craspedellinae observed to possess an ejaculatory sac, it is 'reduced' i.e. contained within the copulatory bulb musculature. In the shadow of this uncertainty, we chose to retain the name $C$. spenceri to describe the worm with large lamellations. However, additional exceptional circumstances exist in that the crayfish host reconded by Haswell (1893) cannot be reliably identified, and the localities he provided are vague and wide ranging. Therefore, we erect a neotype for $C$. spenceri from what is in our opinion the host most likely to have been collected by Haswell (1893) (i.e. Cherax destructor), from a locality approximately at the middle of the geographical range of
the erayfish (John Short, personal communication).
Our field collecting has not been exhaustive, We predict that with further field examination of crayfish hosts, the branchial chamber habitat of Australian crayfish will reveal a greater diversity of the Craspedellinae. Moreover, there is evidence that the group also occurs outside Australia. A undescribed, putative species of Craspedella with a cirrus clearly different to that of any of the species described in the present study, collected from the crayfish Cherax communis Holthuis, 1949 from Papua New Guinea, is held in the private collection of Dr Boris Joffe of the Zoological Institute, St. Petersburg, Russia (B. Joffe, personal communication),

## ACKNOWLEDGEMENTS

The contribution of KBS to this study forms part of a PhD within the Department of Parasitology and Anatomical Sciences, the University of Queensland.

First, we wish to thank the Australian Biological Resources Study for a grant ( $87 / 5909$ ) to LRGC which funded the study. We thank museum staff of the state museums of New South Wales, Victoria and Westert Australia, who assisted greatly in appraising collections and records of crayfish to assist in locating suitable collecting sites, most notably Dr Penny Baerents, Australian Museum, Dr Gary Poore, Museum of Victoria and Dr Gary Morgan, Western Australian Museum. We are indebted to Dr Don Horning from the McLeay Museum, University of Sydney for his attempts to locate specimens or data pertinent to Haswell's collections. Dr Pierre Horwitz (Curtin University) and Dr Brenden Knott (University of WA) provided valuable assistance with WA crayfish localities and habitats and Dr Louis Evans (Edith Cowan University)) provided data of Western Australian temnocephalans. Mr Wolfgang Zeidler, South Australian Museum and Dr lan Beveridge, University of Melbourne kindly provided data and worms respectively. Mr John Short of the Crustacean Section of the Queensland Museum (QM) was extremely helpful in the identification of crayfish and with literature on the hosts. Furthermore, we would like to thank Christine Lee and Zeinab Khalil (QM) for their intelligent and dedicated attention to specimen preparation in the laboratory. Dr Boris Joffe of the Zoological Institute, St. Petersburg, Russia, enlightened us to the value of de Faure's preparations of the cirrus and provided
invaluable expert advice. We thank officers of the National Parks and Forestry in all states for assistance with locating crayfish habitats.

## LITERATURE CITED

ALDERMAN, D.J. \& POGLASE, JL. 1988. Pathogens, parasites and commensals. Pp. 167-212. In Holdich, D.M. \& Lowery, R.S. (eds.) 'Freshwater Cray fish Biology Managementand Exploilstion: (Croom Helm Ltd: London),
BAER, J,G. 1931. Etude monographique du groupe des Temnocéphales. Bulletin biologique de la France el de la Belgique 65: 1-57.
1953. Zoological results of the Dutch New Guinea Expedition 1939 No. 4. Temnocéphales, Zoologische Mededelingen Leiden 32: 119-140,
1961. Classe des Temnocéphales, In P.P. Graasé (ed.) "Traité de Zoologie" (Patix Masson et Cie). 4: 213-241.
BRESSLAU, E \& REISINGER, E. 1933, Turbellarin. Pp. 52-308. In Kuckenthal, W. \& Krumbach, T. (eds.) 'Handbook de Zoologie'. Bd. 2., H.1. (Walter de Gruyter und Co:/ Berrin-Leipzig.)
CANNON, 1986, 'Turbellaria of the World-A guide to Families and Genera'. (Queensland Museum; Brisbane.) 136 pp .
CANNON, L.R.G. 1991. Temnocephalan symbionts of the freshwater crayfish Cherax quadricarimans from northern Australia. Hydrobiologia 227:341347.
1993. New temnocephalans (Platyhelminthes): ectosymbionts of freshwater crabs and shrimps. Memoirs of the Queensland Museum 33: 17-40.
CANNON, L.R.G. \& JENNINGS, J.B. 1987. Ocourrence and nutritional relationships of four ectosymbiotes of the freshwater crayfishes Cherax dispar Riek and Cherax punctatus Clark (Crustacea: Decapoda) in Queensland. Australian Journal of Marine and Freshwater Research 38: 419-427.
CANNON, L.R.G. \& SEWELL, K.B, 1994. Symbients and biodiversity. Memoirs of the Queensland Museum 33: 36-40.
CANNON, L.R.G. \& WATSON, N.A. (in press). The postero-lateral glands of Temnocephala minor Haswell, 1988 (Platyhelminthes, Temnocephalida). Australian Journal of Zoology.
DALLWITZ, M.J. \& PAINE, T.A. 1986. Uset's guide to the DELTA system: a general system for processing taxanomic descriptions. CSIRO. Division of Entomology, Report 13: 1-106.
HASWELL W.A. 1893. A monograph of the Tcmnocephaleae, Proceedings of the Linnean Society of New South Wales (Macleay Memorial Volume) pp. 94-152.
HICKMAN, V.V. 1967. Tasmanian Temnocephalidea. Papers and Proceedings of the Royal Society of Tasmania 101: 227-250.

HYMAN, L.H. 1951. The invertebrates. I1: Platyhclminthes and Rhynchocoela. McGrawHill Book Co. Inc. New York. 550 pp.
JENNINGS, J.B. 1988. Nutrition and respiration in symbiotic Tusbellaria. Pp. 1-13. In Ax, P., Ehlers, U. \& Sopott-Ehlers, B. 'Free-living and Symbiotic Plathelminthes". (Gustav Fischer: Stuttgart).
JENNINGS, J.B., CANNON, L.R.G. \& HICK, A.J. 1992. The nature and origin of the epidermal scales of Notodactylus handschini - an unusual temnocephalid turbellarian ectosymbiotic on crayfish from northem Queensland. Biological Bulletin 182: 117-128.
JONES, T.C. \& LESTER, R.J.G. 1992. The life history and biology of Diceratocephala boschmai (Platyhelminthes; Temnocephala), an ectosymbiont on the redclaw crayfish Cherax quadricarinatus. Hydrobiologia 248: 193-199.
MATJASIC, J. 1990. Monography of the family Scutariellidae (Turbellaria, Temnocephalidea), Acadernia Scientiarum el Anium Slovenica Classis IV: Historia Naturalis 28: Znanstvenoraziskovalni center SAZU, Bioloski Institut Jovana Hadzija 9 (Ljubljana: Slovenska Acadcmija Znanosti in Umetnosti), 167 pp.
MORRISSY, N.M. \& CASSELLS, G. 1992. Spread ol the introduced yabbie Cherax albidus Clark, 1936 in Western Australia. Fisheries Research Report Fishcries Department of Western Australia 92: 1-27.

ROHDE, K. 1987a. Ultrastructural studies of epidermis, sense receptors and sperm of Craspedella sp. and Didynorchis sp. (Platyhelminthes, Rhabdocoela). Zoologica Scripta 16: 289-295.
1987b. Ultrastructure of tlame cclls and proIncphridial capillaries of Craspedella and Didymorchis (Platyhelminthes, Rhabdocoela). Zoomorphology 106: 346-351.
SEWELL, K.B. \& CANNON, L.R.G. 1995. A scanning clcctron microscope study of Craspedella sp. from the branchial chamber of redelaw crayfish. Che rax quadricarinatus, from Queensland, Australia. Hydrobiologia 305: 151-158.
SEWELL, K.B. \& WHITTINGTON, I.D. 1995. A light microscope study of the attachment organs and their role in locomotion of Craspedella sp . (Platyhelminthes: Rhabdocoela: Temnocephalidac), an ectosymbiont from the branchial chamber of Cherax quadricarinatus (Crustacea: Parastacidae) in Queensland, Australia. Joumal of Natural History. 29:1121-1141.
WATSON, N.A., ROHDE, K. \& SEWELL, K.B. 1995. (In press). Ultrastructure of spermiogenesis and spermatozoa of Decadidymus gulosus, Temnocephala dendyi, T. minor, Craspedella sp., C. spenceri and Diceralocephala boschmai (Platyhelminthes, Temnocephalida, Temnocephalidae), with emphasis on the intercentriolar body and zone of differentiation. Invertebrate Reproduction and Development.27:131-143.


[^0]:    FIG. 10. Light photomicrographs: A, Craspedella spenceri, Longitudinal section through centre of specimen QMGL 18490 showing weak pharynx and 3 prominent lamellac. Scale $=200 \mu \mathrm{~m}$. B, longitudinal section through anterior end of Heptacraspedella peratus gen. \& sp. nov. showing large, elongate excretory ampullae. Scale $=$ $100 \mu \mathrm{~m}$. C, copulatory bulb of live Craspedella pedum sp, nov, showing 'reduced' ejaculatory sac contained within the musculature of the bulb. Scale $=50 \mu \mathrm{~m} . \mathrm{D}$, copulatory bulb from wholemount of Craspedella shorti sp . nov. Note absence of ejaculatory sac and bacoate pattern formed by the prostate duct reservoirs. Scale $=$ $50 \mu \mathrm{~m}$, E, vagina of Craspedella spenceri cleared in de Faure's medium to reveal shape of vaginal cavity. Scale $=50 \mu \mathrm{~m}$. F , vagina of Craspedella simulator sp . nov, cleared in de Faure's mediumi to reveal shape of vaginal cavity and prominent lateral pocket. Scale $=50 \mu \mathrm{~m}$.

